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सिलिकॉन कार्बाइड अग्नि-सह सामग्रियों का सर्वस्वीकृत वर्गीकरण

Standard Classification of Silicon Carbide (SiC) Refractories

ICS 81.080

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भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

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Refractories Sectional Committee, MTD 15

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards after the draft finalized by the Refractories Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard classifies shaped and unshaped refractories that have at least 60 percent of its chemical constituents as SiC into Alumino-Silicate Bonded SiC (ASBSC), Self-Bonded SiC (SBSC), Silicon Nitride Bonded SiC (SNBSC) and Oxinitride Bonded SiC (ONBSC) on the basis of bonding phase in the refractory composition.

Silicon Carbide bricks have excellent properties like high thermal conductivity and thermal shock resistance, Low thermal expansion coefficient, high corrosion resistance, high bending strength, and excellent resistance to liquid aluminum erosion capability. SiC brick is particularly ideal for application in high temperature furnaces and in waste incineration plants

For the purpose of deciding whether a particular requirement of this standard is complied with the final value observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

STANDARD CLASSIFICATION OF SILICON CARBIDE (SiC) REFRACTORIES

1 SCOPE

This classification covers shaped and unshaped refractories that have at least 60 percent of its chemical constituents as SiC. These refractories have excellent resistance to erosion and thermal shock as well as have a high hot strength and very high thermal conductivity. These refractories find use in many high temperature industrial applications, including ferrous and non-ferrous metallurgy, power generation, waste heat recovery, ceramic kilns, cement kilns and incinerators.

2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards are indicated below:

IS No.	*Title*
1528 (Part 4) : 2012	Methods of sampling and physical tests for refractory materials: Part 4 Determination of cold crushing strength of dense shaped refractories products (*second revision*)
1528 (Part 5) : 2007/ ISO 5014 : 1997	Methods of sampling and physical tests for refractory materials: Part 5 Method for determination of modulus of rupture at amblent temperature of dense and insulating shaped refractory products (*third revision*)
1528 (Part 15) : 2020/ ISO 5017 : 2013	Methods of sampling and physical tests for refractory materials: Part 15 Method for determination of bulk density, apparent porosity and true porosity of dense shaped refractory products (*second revision*)
1528 (Part 20) : 1993/ ISO 5013 : 1985	Methods of sampling and physical tests for refractory materials: Part 15 Determination of modulus of rupture at elevated temperature
4041 : 2006/ ISO 836 : 2001	Terminology for refractories (*first revision*)

3 TERMINOLOGY

For the purpose of this standard definitions given in IS 4041 shall apply.

4 CLASSIFICATION

4.0 Basis of Classification

The general microstructure of the SiC based refractories can be described as a discontinuous SiC aggregate phase held together in a continuous bond phase matrix. These refractories are classified not with regards to the amount of SiC present, but with respect to the bonding phase in the refractory composition.

4.1 Alumino- Silicate Bonded SiC (ASBSC)

The primary form of ASBSC refractories are the clay-bonded SiC class of refractories. However, other purer forms of aluminosilicate sources, such as silimanite, can be used to make these refractories. These materials are particularly useful in non-ferrous metallurgy. However, they show limited resistance to the attack of molten salts. The refractories are generally processed by reaction bonding of silicon carbide grains with an alumino-silicate compound such as silimanite. The processed refractory contains silicon carbide matrix bonded with mullite phase, where the latter is formed during the high temperature sintering stage. Some of the typical properties are supplied in Table 1.

4.2 Self- Bonded SiC (SBSC)

In this variety silicon carbide forms the major matrix phase as well as the bonding phase. However, these refractories are manufactured by the use of different polymorphic phases of SiC, namely *alpha* and beta SiC. In general a*lpha*-SiC forms the matrix phase, which is bonded by fine particulates of *beta*-SiC. *See* Table 1 for a typical set of properties.

4.3 Silicon Nitride Bonded SiC (SNBSC)

In this class of refractories *alpha*-SiC constitutes the major phase, which is bonded by a continuous network of either alpha or *beta* silicon nitride. These are manufactured by reaction sintering of a mixture of SiC and metallic Si under nitrogen firing atmosphere. These refractories sometimes have minor amounts of unreacted residual silicon. This class of refractories exhibit excellent high temperature properties, including high wear resistance, high strength at elevated temperatures, high thermal conductivity imparted by the presence of *alpha*-SiC grains. These refractories are known for their extremely high hot strength and outstanding oxidation and corrosion resistance. Some of the properties are included in Table 1.

4.4 Oxinitride Bonded SiC (ONBSC)

This class of refractories is, similar to the SNBSC group, composed up of a discontinuous SiC phase that is bonded by a continuous silicon oxynitride (Si_2ON_2) phase. However, minor amount of oxides and nitrides of other cations, such as aluminium (Al), may also be present. The silicon oxynitride phase can be replaced with SiAlON phase while keeping the matrix phase the same as *alpha*-SiC. These are manufactured by nitriding a mixture of SiC, Si, Al and a source of oxygen. Typical properties are listed in Table 1.

4.6 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

Table 1 Properties of Various Types of Bonded SiC Refractories

(*Clauses* 4.2, 4.3, 4.4 *and* 4.5)

Properties	ASBSC	SBSC	SNBSC	ONBSC	Refer to IS
Silicon Carbide (SiC) (percent), *Min*	80	90	72	85	*
Silicon Nitride (Si3N4) (percent), *Min*	–	–	20	–	
Nitrogen (N) (percent), *min*	–	–	–	5	
Bulk density(BD) (gm/cc), *Min*	2.50	2.58	2.60	2.54	IS 1528 (Part 15)
Apparent porosity(AP) (percent), *Max*	16	13.5	15	19	IS 1528 (Part 15)
Cold crushing strength(CCS) (kg/cm^2), *Min*	600	1500	1600	1600	IS 1528 (Part 4)
Modulus of rupture(MOR) (kg/cm^2), *Min*					
At room temperature (RT)	150	175	400	350	IS 1528 (Part 20)
At 1400 °C	150	350	440	280	IS 1528 (Part 5)

*Until the Indian standards are published the chemical analysis may be carried out by the method as agreed to between purchaser and supplier.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	2323 7617 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	2337 8499, 2337 8561 2337 8626, 2337 9120
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg CHANDIGARH 160019	265 0206 265 0290
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442 2254 2519, 2254 2315
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